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Simple Economics of Inflation

Heaven help this country if the two political parties in Parliament push to their ultimate conclusions the arguments they used in last week's debate on the ecomic situation ! For, though there is no division between them in their assessment of the present economic state of the nation the remedies they propose are utterly opposed. Neither, alone, dares to propose the remedy that is really needed. The situation in fact is basically quite simple. Wages have been rising faster than the rate of production. Salaries have risen in sympathy. So, too, have dividends. Necessarily prices have had to follow. To defeat that inflation purchasing power must be restrained until the rate of production has caught up. The socialist "cure" seems to be to apply controls to prevent people spending money on things deemed inessential. But as that method could not reduce purchasing power but could only divert it into even less desirable channels it appears to us decidedly unpromising. The conservative idea is to strike at credit expansion. But that is a blunt instrument. For its main effect is to check investment in capital equipment at the very time when there is plenty of evidence that this country is already expending too small a fraction of its total resources on new equipment. The ultimate effect, it is true, must be so to reduce finance available to industry that resistance to wage claims will grow. But nobody surely wants to combat inflation through the creation of industrial strife ? What is really needed is a direct attack on the root cause of inflation. It is the demand not for capital goods but for consumption goods that needs to be checked. Even in this New Year it is not too late to prevent the present round of excessive wage claims having the inevitable inflationary effect. The excess purchasing power needs to be drawn off by direct or indirect taxation, by the reduction of subsidies, by restrictions on hire-purchase transactions and the like. Thereafter there needs to be a "holiday" in wage and salary claims and in the advance of dividends extending over, possibly, a year or two. By adopting so direct a means of attack investment in the new capital goods that can rapidly increase the national output need go unaffected and the real standard of living be the more rapidly improved. But politically such a policy would be so unpopular that neither conservatives nor socialists seem likely to contemplate taking it. Is there no possibility of an agreement between the parties to do it jointly?

Institution of Electrical Engineers

Nearly 1,500 members and guests attended the annual dinner of the Institution of Electrical Engineers in London on February 23rd, when His Royal Highness the Duke of Edinburgh received his certificate of honorary membership from the President of the Institution, Sir George Nelson. After the loyal toast had been honoured, the toast of the Institution of Electrical Engineers was proposed by the Duke of Edinburgh who said that, in his tours abroad, he had become convinced that the scope for the services of engineers everywhere was unlimited. But British engineers must keep abreast of their rivals or they would find that their services were not wanted. Better still, if they could forge ahead of their rivals the prospects were extremely rosy. He thought that the electrical industry was making an outstanding contribution to the national economy by the efficiency with which it converted coal and oil into energy—an achievement which would be of increasing importance as long as fossilised fuels were used for the production of energy. The electrical industry was also helping to strengthen the country's economy by exporting a large portion of its products. But, His Royal Highness concluded, there was no room for complacency, for, if the Institution were to lose sight of the hard facts of commercial existence, by becoming too preoccupied with its professional standing and that of its members, both the industry and the country would suffer. In his reply to the toast Sir George Nelson said that the Institution cherished the words of Her Majesty in her Christmas broadcast when she said "we must adventure on if we are to make the world a better place". Sir George asserted that that was the philosophy of the Institution of Electrical Engineers and that it left no room for complacency. Speaking of the shortage of scientists and engineers Sir George said, "not only must we ensure an adequate supply of trained men but we must also ensure that, when they enter research establishments and industry, the most efficient use is made of their services and that their efforts are not inhibited by administrative defects. In fields under the control of Government departments much waste of technical man-hours arises through the application of the annual budgeting system to the long term projects of development and production. In industry too, there is evidence of the multiplication of technical effort on developments of a similar nature in answer to calls for more competition. Competition is undoubtedly good in principle but not if it reaches the stage where it causes waste of scientific and technical resources." The toast of the guests was proposed by Mr. J. Eccles, the immediate past-president of the Institution, and the response was made by Sir Cyril Hinshelwood, president of the Royal Society.

Nuclear Energy in Industry

Last week, two announcements were made about the formation of companies for the industrial development of nuclear energy. The first of them came from Vickers Ltd, which has applied for the registration of a subsidiary company entitled Vickers Nuclear Engineering Ltd. Rolls Royce Ltd., and Foster Wheeler Ltd., are associated with Vickers Ltd., in the constitution of this new company, although it has been stated that the three firms can act independently or as a group. The first task of the new company is to be the application of nuclear energy to marine propulsion. Rear-Admiral L. E. Rebbeck has joined the staff of the Vickers group to take executive responsibility for the nuclear development project. The second announcement concerns the formation of a company entitled A.E.I. John Thompson Nuclear Energy Company Ltd., which has been incorporated with an issued capital of £1,000,000. This capital is held in equal amounts by the British Thomson-Houston Co. Ltd., Metropolitan-Vickers Electrical Co. Ltd., and John Thompson Ltd. The new company, with its head office at Oak House, Cross Street, Sale, Cheshire, absorbs and replaces the A.E.I. John Thompson Nuclear Energy Group. Its principal objects are the development, design and supply of nuclear reactors of all kinds, and it will act as the main contractor for the construction of nuclear power stations. At present, the company is constructing a research reactor at the A.E.I. research establishment at Aldermaston.

High-Energy Radiation Laboratory at Hinxton Hall, Cambridge

Last week we visited a new high-energy radiation laboratory, for research into the irradiation treatment of materials, which has been installed at Hinxton Hall, Cambridge, the research centre of Tube Invesments Ltd. It is believed to be the first industrial installation of its kind in this country to use commercially available equipment specifically designed for the irradiation of materials. It may be recalled that high-energy radiation, either from a radioactive source such as pile, or from a particle accelerator, can promote, at ordinary temperatures, chemical changes which could not be effected by chemical methods or heat treatment. Some of the more interesting of these chemical reactions take place when plastics are irradiated but irradiation methods are applicable over a much wider field, including sterilisation of foodstuffs and pharmaceutical products, medicine and agriculture. With the radiation equipment installed at Hinxton Hall research and development work will be possible on a larger scale than the small laboratory experiments hitherto undertaken in this country. The main item of equipment is a Van de Graaff generator capable of producing a high intensity beam of radiation at 2 million volts. It was built by the High Voltage Engineering Corporation of Cambridge, Massachusetts. It can be adapted to produce gamma radiation, fast protons or neutrons. Normally, when accelerating electrons with energies up to 2 MeV, the beam current (maximum) is 250 microamperes. The generator is housed in a pressure vessel and operates in an atmosphere of 25 per cent nitrogen, 75 per cent carbon dioxide at a pressure of 275 lb. per sq. in. which enables the overall dimensions to be kept small. Articles to be irradiated are taken on a series of conveyor belts from the control room into the radiation chamber where the electron beam from the generator is scanned electromagnetically across the belt carrying the specimens. The conveyor system traverses a labyrinth of demountable concrete walls which provide the operators with protection against radiation effects. Three other items of radiation equipment are being provided in the laboratory : first, an X-ray source operating at 250 kV, giving high penetration with low beam intensity ; secondly, an X-ray source 50kV, with low penetration, suitable for surface treatment ; and thirdly, a high intensity radioactive cobalt source giving gamma radiation of high penetration at 1·3 million volts, with control of dosage rate.

LITERATURE

Electroplating Engineering Handbook. Edited by A. KENNETH GRAHAM. London: Chapman and Hall, Ltd., 37, Essex Street, Strand, W.C.2. Price 80s.

NOT so very long ago electroplating was carried out by craftsmen using pitch-lined wooden tanks assembled in a small back-yard; knowledge of the craft was handed down by word of mouth. The opportunities and the competition which come with mass demand have forced the plating trade to become more mechanised. But there are still very few books which summarise the experience gained in the course of this development. The book under review is the most ambitious attempt so far to satisfy an obvious need. Among the forty contributors to the volume are many of the foremost experts in the American electroplating field; readers can therefore rest assured that the information given in the book is correct and up-to-date. The multiple authorship, however, and an insufficiently ruthless editor bring with them certain disadvantages referred to below.

The book is divided into two parts entitled "General Processing Data" and "Engineering Fundamentals and Practice," respectively. This division has largely been adhered to in the separate articles, but it should be noticed that the first part contains some information on the construction of tanks for cleaning and plating, on some questions of general layout and on the various procedures used for costing. It contains general reviews of mechanical and chemical pretreatments, plating bath and chemical dip compositions and operating conditions, and of the analysis of solutions and the testing of deposits. The account given of these processes and methods is satisfactory for the plating engineer who uses them and who wants to carry out his work in an efficient manner. Particular attention is paid to questions such as water requirements, waste disposal and the costs involved in various operations.

But many detailed criticisms can be made of this part. Many faults are attributable to the excessive respect shown to commercial interests by the contributors. Thus, in one chapter, drawings of installations cover only the products of one firm with which the author of the chapter is associated; inhibitors in acid pickling are mentioned only in the most general way; no details are given of electrolytic descaling beyond the mention of two commercial methods; the composition ranges given for the chemical polishing of aluminium are far too wide for practical use and do not refer to the methods developed in Germany; and the chapter on "trouble shooting," written by an expert on bright nickel deposition, makes no mention of the deterioration of plating solutions with use. The description of methods of thickness testing which are of great importance in judging the success of the plating operation is not full enough in some respects and misleading in others. There are references to, but no details of, methods of measuring stress and ductility.

The second part of the book deals with plating shop construction in general, e.g. layout of shops, construction of floors and of exhaust systems. There are also chapters on heating and cooling of tanks, automatic plating machines, filters, electrical supply equipment, &c. These subjects are treated so that a plating engineer, without actually being told how to make the items in question, is yet able to maintain them and to understand the general principles involved in their manufacture.

The text as a whole is written far too diffusely; much of it reads more like a friendly chat than like a handbook; verbiage such as "Unless full advantage is taken of its potentialities, however, the greatest economy will not be realised" abound throughout; the chapter on "the visual inspection of plated parts," for example, occupying seven pages, could well have been reduced to a page and a half. Drastic cutting of the text would have reduced the price of the book and made it more readable.

The potential English buyer should also note that the book deals exclusively with United States practice, specifications and health regulations. If he does decide to buy the book he will find in it much useful matter which is not readily available elsewhere.

Applied Electricity. By H. COTTON, D.Sc., M.I.E.E. London: Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, W.8. Fourth edition. Price 20s.

TWENTY years ago it was possible to write a book on electrical technology secure in the belief that, whatever revision might be required for later editions, the fundamental units, at least, would remain inviolate. To-day one is less sure, for, since the war, the claims of new systems of units, based on the metre, kilogramme and second (m.k.s.), have been successfully asserted. Some authors have approached these changes with circumspection, wishing neither to confuse the young student by introducing a new system of units, nor to make him wonder how it was that his predecessors managed so well with the old system. Not so Dr. Cotton, who, in revising the text of his *Applied Electricity*, has made a virtue out of necessity by exploiting the main advantage of the rationalised m.k.s. system, which is, that it represents the consolidation of several independent systems into a single one applicable to all electrical calculations. He points out the close analogy which can now be shown to exist between geometrically similar electrical and dielectric problems. Because of this very close analogy a student who is equipped to solve a given electrical circuit problem should be capable of applying the same method to a corresponding problem in electrostatics. This new approach to the subject of electrostatics is expounded in an additional chapter, which should appeal particularly to students and which adds materially to the value of the book.

Fuel: Solid, Liquid and Gaseous. By J. S. S. BRAME and J. G. KING. London: Edward Arnold, Ltd., 41, Maddox Street, W.1. Fifth edition. Price 50s.

THIS book, rewritten by Dr. King, follows the pattern of earlier editions and provides a general introduction to fuel technology suitable for science graduates. It opens with a survey of world resources and consumption of fuels of all kinds, including nuclear power. The principles of flame and combustion are then discussed, and in five further chapters the characteristics and classification of solid fuels are considered. This section of the book also includes an account of coal carbonisation, of the properties of coke and other smokeless fuels, and of equipment in which these substances are burned.

Liquid fuels occupy another five chapters. In the first of these an account is given of the occurrences and composition of petroleum. This is followed by details of the methods now employed for refining and cracking petroleum oils. This part of the book also includes descriptions of shale oil, coal tar and products obtained by the hydrogenation of coal and by the Fischer-Tropsch synthesis. The final section on liquid fuels is concerned with the requirements of internal combustion engines and with methods used for testing fuels suitable for such engines.

Three chapters are then devoted to gaseous fuels; in these there are good descriptions of the preparation of gases from coal, coke and oil, together with reference to the occurrence and use of natural gas. Three final chapters contain much useful and important information on sampling and analysis of fuels, on methods available for determination of fuel efficiencies, and on the factors affecting the choice of fuel for any particular purpose.

The contents of this book are well presented and the illustrations and diagrams are clear and helpful. There are, however, some errors in the text; on page 4, 4,000,000 tons of coal should be shown as equivalent to 1,500,000kWk, and on the second line of page 11, an extra factor of 1,000,000 has been inserted. On the same page, the coal equivalent of surplus wood is given as about 1000 times what it should be, and in the formula on page 383 for the Wobbe index, the square root sign should be added both to density and to specific gravity. These minor blemishes in no way prevent this new edition from retaining the high position established by earlier versions of the book.

Industrial Furnaces, Volume 2. By W. TRINKS. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Third edition. Price 80s.

THE new edition of this book has been extensively revised and much of it rewritten to bring the subject matter up to date in view of the developments which have taken place since the last edition was published in 1942. The main sections of the book deal with fuels and electric energy; combustion devices and heating elements; control of furnace temperature and furnace atmosphere; labour-saving appliances; a critical comparison of fuels and of furnaces and safety measures.

Books Received

Research Reactors. U.S. Atomic Energy Commission. London: McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 49s.

Reactor Handbook—Physics. U.S. Atomic Energy Commission. London: McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 90s.

Shop Mathematics. By C. E. Stout. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 30s.

Prestressed Concrete. By Y. Guyon. Contractor's Record, Ltd., Lennox House, Norfolk Street, Strand, London, W.C.2. Price 70s.

Factory Electrification. By F. T. Bartho and C. H. Pike. Macdonald and Co. (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 35s.

Practical Metrology. Volume II. By K. J. Hume and G. H. Sharp. Macdonald and Co. (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 7s. 6d.

Idées Actuelles sur la Technologie du Béton. By Robert L'Hermite. Paris: La Documentation Technique, Du Batiment et des Travaux Publics, 6 rue Paul-Valéry, Paris, XVIe. Price 2000 francs.

Households and Earners

By GERTRUDE WILLIAMS

THE annual cycle of wage claims is now in full spate and the familiar arguments are being developed by both sides. On the one hand stress is laid on the continual effort needed to make ends meet when the cost of living goes up month by month; on the other, it is argued that our industries will price themselves out of the fiercely competitive world market if higher wages involve them in increased labour costs. There is, in fact, the same duality of conception that has made wage bargaining so difficult from the time when collective bargaining first began to develop.

To the wage-earner the wage he receives is not a nicely calculated element in the costings of the product, but the determining factor in the standard of living of himself and his family; and the early, and still accepted definition of a trade union as "an association of workpeople for the maintenance and improvement of the standard of living" underlines this idea. From the beginning, however, there was a difficulty in the pursuit of this objective. Men live their lives as members of families but they work as individuals. An employer, when choosing a man to fill a vacancy, is not concerned whether he is married or single, whether he is childless or has a large family or whether there are any other dependents for whom he is responsible. Yet this is, in practice, what determines the adequacy of the wage to the person employed. Not that there has ever been a demand from workers that their pay should be related to their family responsibilities—rather the opposite. From the outset it was realised that the only sure safeguard was to work for the establishment of occupational rates—that is, for pay based on the kind of work done and not on the circumstances of the person doing it. Any other system would undoubtedly have led employers to reduce the wages bill by giving the preference in jobs to those with the smallest family responsibilities. A great deal of work has been put into getting firmly established the principle that the employer should not be entitled to choose between applicants for a job on any other grounds than those of competence for the work.

The need to reconcile the "occupational rate" with the concept of the "living wage" led to the myth of the "typical family." There was no need, it was argued, to bother about the difference between the "rate for the job" based on the nature of the work done, and the "needs of the worker" based on his responsibilities as breadwinner for a family, because, in fact, most workers do have wives and children to support and the unit of "man, wife and three dependent children" gained wide currency as the standard by which the adequacy of earnings should be measured.

Like most myths this "typical" family unit bore little relation to the facts. One of the extraordinary features of human nature is the extent to which people can continue to believe in something despite all the evidence of their own experience; and the "five member family" figured constantly in all discussion of wage and social policy though most people might have realised it was nothing but a convenient abstraction, if they had taken the trouble to look at their own situation and those of their friends. It was Miss Eleanor Rathbone, that doughty, independent fighter for unpopular causes, and for many years Member of Parliament for Liverpool, who first forced upon public attention the true facts of the situation. In a book called "The Disinherited Family" she made a devastating analysis of the actual, rather than the "notional" composition of households in this country. The material for this analysis was compiled by Dr. Bowley, one of the most eminent of all statisticians, and was the result of a scrutiny of working class households in Lancashire, Yorkshire, the Midlands, the West Country and London—a sufficiently widely chosen sample to be accepted as national. This showed that the five member family, far from being typical, was actually one of the smallest groups in the community. Of adult working men, that is, men over twenty years of age, under 9 per cent had a wife and three dependent children (i.e. below school leaving age – 14); 27 per cent were either bachelors or widowers with no dependent child, 24·7 per cent had a wife but no dependent child, and 29·6 per cent had a wife and either one or two children, whilst just under 10 per cent had more than three children. It is important to understand just what these figures relate to. They do not mean that no more than 9 per cent of working men ever have more than three children—this was certainly not true of the early part of this century when this material was compiled and the birth rate of working people was fairly high. These men may have had other children who were now old enough to be out in the world; and most of the men included in the 27 per cent bachelors or childless widowers would either marry and have children in the future or had had children in the past. But at any one period of time the family that a working man had to support, and which dominated people's ideas when considering the adequacy or otherwise of wages, was actually very different from the "five member unit." Indeed, if wages were settled with this size family in mind, provision would be made for millions of mythical children (the non-existent dependents of the 81 per cent of adult working men with less than three children) whilst failing to take into account the unfortunate children of the 10 per cent with more than three to provide for, who had real, instead of mythical, stomachs to be filled and bodies to be clothed.

Confirmation of this analysis was later made by Mr. Colin Clark, the eminent statistician, in his book "Income and Outlay." Mr. Clark introduced an entirely new approach to the problem of the distribution of wealth by relating incomes to the numbers to be maintained by them. Instead of dividing the community, as is usually done, into groups according to the incomes received by individuals, he made his classification according to the amount of income per head, recognising that a man who gets £300 a year and has only himself to maintain is comparable, not with another who has the same £300 but a wife and a couple of children to provide for, but rather with the family man of a much larger income. On this basis of analysing income per week per head he found that whilst the two lowest groups—those with less than 10/- per head and those with 10/- to 15/- (it is necessary to remember that money values have more than halved since this analysis was made) contained considerably less than a third of the population, they were responsible for more than half of the children below school-leaving age and half of these children were in the group with the lowest income per head.

Such studies as these revolutionised our attitude to poverty. It had been customary before this to measure the extent of poverty by calculating the amount required to maintain a family at current prices, on the minimum standard of subsistence acceptable to the community. Those whose incomes fell below this amount were automatically reckoned to be in poverty in the statistical sense of the term, and it was one of the matters on which we—justifiably—congratulated ourselves that this percentage of the population had decreased so remarkably during the present century. But these studies drew attention to the fact that the incidence of poverty is not static as this assumes. One cannot say "These families are below the poverty line and these are above it." The truth is that most families go through a cycle of experience. The majority of adult men earn enough to keep themselves and their wives and this was true of times when wages were much less favourable than they are now. But as each baby was born whilst the wages (being based on the man's occupational rate) remained the same, the strain grew greater and greater. It reached the point of maximum difficulty when the family was complete but the eldest child was not yet old enough to leave school and contribute to the family exchequer; and it was during this time that there was the greatest likelihood of falling below the poverty line. As each child emerged into the field of employment, the burden grew lighter until, when all were grown up and had left home, the family returned to the position from which it had started with only the worker and his wife to be maintained.

A startling illustration of the difficulties due to the wide variation in the needs of families of varying sizes, when wages are standard for the occupation, was provided by the situation of the long-term unemployed in the unhappy period between the two wars. When compulsory unemployment insurance was first introduced on a national scale in 1920 there was no intention of providing more than a foundation for personal savings, and the benefit did not vary with family circumstances, but it was quickly realised that this was no way of dealing with unemployment which might, and did, continue for months or even years at a stretch. Insurance benefit had to be raised to provide basic subsistence and this meant that the number of dependents had to be taken into account. We then had the situation in which the unemployment allowances, based on the number in the family, came perilously near to the wages of the unskilled labourer; in fact, had it not been for the "wages stop" a man with a large family would have drawn a larger income when out of work than the earnings of his grade if he had been employed.

All these factors led finally to the introduction of family allowances, a weekly sum provided out of national funds, for all parents with more than one child to support. Modest as has always been the amount of the allowance, it is of the greatest social importance in recognising, in practice, for the first time the impossibility of reconciling standard occupational rates of wages with varying family needs. Since the passing of the Family Allowances Act, 1945, each head of a family has had two quite distinct sources of income—one, his earnings, which are the payment for the work he does, the other, the family allowance, paid out of public funds

and bearing no relationship at all to his work or his occupational status.

Since then, assistance to families, whilst still on a somewhat parsimonious scale, has much increased. The application of income tax to smaller incomes, made possible by the introduction of P.A.Y.E., has given the benefit of rebates for dependent children to wage-earners with families, so that (on the tax rates effective in 1954–55) whereas a single person earning £500 a year pays £112 10s. income tax, a man with a wife and two children and earning the same amount, pays nothing. The National Health Service, free education, milk in schools, and rent rebates, all similarly favour the family man.

It is not argued here that the social assistance to families is such as to equalise the burden on the family man with that of the bachelor ; but it *is* argued that the situation is very different indeed from what it was when collective bargaining was first introduced and the desperate attempt to reconcile incompatibles—the standard occupational rate and the needs of the family—began its long history. Yet despite this, these profound changes have had hardly any influence on people's arguments in wage negotiations and the notion of the " typical family " continues to bedevil our whole thinking on wage matters. One topical illustration of this may be given. The long wrangle over the question of Equal Pay for Equal Work has been affected by many ideas and prejudices—both economic and social—but there is no doubt that the factor which has had the most potent influence is the difficulty that many people experience in believing it could be right to pay a man and a woman the same when the man has a family to support and the woman has not. Everybody knows from their own circle of acquaintance that there are many men without children (or whose children are no longer dependent on them) and many women with others than themselves to maintain ; but the notional idea of the " family man " and the unburdened woman continues, irrationally, to colour their thinking. One half of their mind pulls them towards the justice of paying women the same as men when they do the same work, the other half pulls them in the opposite direction, that it must be " unfair " or " anti-social " for a man with a family to receive the same as a woman without. But what about the man without a family ? Is that also unfair and anti-social ? On the horns of such a dilemma they make their escape by *assuming* the majority of men have families and argue accordingly. Yet this assumption is absurd even without statistical knowledge on which to draw. If a man has three children within six years—quite a usual spacing—the whole period of the dependency of his children, from the birth of the first until the third reaches school-leaving age, is only twenty-one years, and this is less than half the normal male working span of fifty years.

It is because of the profound influence on our thinking of this notional family unit that the material provided by the 1951 Census, and now available to us, is of such interest and anyone analysing it will find his picture of our social structure completely changed. The reduction in the birth rate during the present century has had two distinct but related consequences. In the first place the size of the family is smaller than it used to be. Whereas, in the last quarter of the nineteenth century the modal (or most often occurring) family contained from four to six children, it now contains only one or two, and this reduction is true of all social classes. Not only is the family smaller but a good deal of work that used to be done at home is now done outside. Industrial canteens provide hot cooked meals for the working man, and the school meals service does the same for the children ; mass-produced consumption goods are available in the shops at no greater cost than they could be produced at home, and laundrettes enable washing and drying of clothes to be carried on without any disturbance of home routine. This means that women who used to retire completely from wage-earning occupations on marriage and who did not contemplate returning unless forced to do so by disaster, are now beginning to take it for granted that their withdrawal from the field of employment will be of comparatively short duration. Under the age of twenty-four only a third of women employees are married and up to twenty-nine only just over a half. But from thirty to fifty years of age at least two-thirds of women workers are married women in all age groups. It is evident from this that a new pattern of family life is establishing itself. Most women marry young nowadays—in the early 'twenties—and the majority evidently retire from paid work when their babies are young ; but, as the children reach school age, the mothers come back into employment whether for part or full time. An inquiry into the reasons for this return shows that it is not primarily due to economic necessity, in the sense that the husband's wage is inadequate to provide for basic needs, but, in addition perhaps to the desire for the companionship of the factory, it is due to the wish to combine the economic burden of child-rearing with enjoyment of such amenities as television, better household equipment and furniture or entertainment.

The smaller family, therefore, means not only fewer to support, but more earners to meet the expense. The longstanding assumption that most families consist of the bread-winner on whom depend wife and children is less true to the facts now than ever before. Of all the households in the community more than half—56 per cent—have no children under sixteen years of age within them, 21·5 per cent have only one, and 14·2 per cent have two. That is, 91·7 per cent of all households have two or less children under sixteen (and not all these children are dependent on their parents, for the majority between fifteen and sixteen are earning). But these are not all dependent solely on their fathers' wages. Of the 14,000,000 households in the population less than a quarter—that is, 22 per cent—consist of two adults with children and only one earner. If we take the households which contain any earners at all—that is, excluding those in which all the members are retired from work or live on unearned incomes—we find that 45 per cent have two or more earners.

It is about time, then, that we ceased to distort wage negotiations with false assumptions—assumptions that were never very close to reality, but now have become completely divorced from it. In the last century, when the idea of any legislation to protect the adult man was considered fundamentally wrong, male factory workers got a good deal of protection for themselves by agitating for legal conditions to safeguard women workers—and were taunted with fighting their own battles " behind the women's petticoats." Nowadays, the great majority of working men who have no or few dependents to support, hide, as it were, behind the baby's perambulator and carry on their fight for higher wages for themselves by stressing the difficulties of the man with a large family. If wages were still the only source of income, this might be justified on the grounds that only by getting more for everybody could you ensure sufficient for those with heavier commitments. But this is no longer true. We have now made a distinction between remuneration for work done—wages—dependent on the quantity and quality of the work, and the social income—family allowances and social services—dependent on nothing but the fact of citizenship. If we wanted to we could go further along this path and meet the needs of the family now by increasing the amount of family allowances without using the family man's difficulties to force wages beyond their economic level. It is worth while considering whether our invention of " social income " does not at last free us from the hopeless attempt to make one payment—wages—adjust itself to two entirely different things, economic factors in the world market and social needs of varying families. Might this not enable us at long last to face the fact that wages represent primarily an economic contract and must depend, as do other prices, upon the situation of the market ?

Power Consumption and Oil Fuel

In an address to a fuel efficiency conference, held at Slough recently, Mr. H. Cunliffe, the general manager of Industrial Fuels, Shell-Mex and B.P., Ltd., stated that it would be necessary for 25 per cent of industrial coal users to convert to oil fuel. In support of his statement, Mr. Cunliffe recalled that Britain's consumption of energy had risen from 200 million tons in 1946 to 250 million tons of coal equivalent by 1955. Increased fuel and power consumption was related to the standard of living, to narrowing the balance of payments gap and to the maintaining of full employment so that, he continued, the energy gap might be 50,000,000 tons in 1960 and 75,000,000 tons by 1975, or as much as 60,000,000 tons by 1960, increasing to 125 million tons in 1975. To meet the increased demand for power would call mainly for more distillate fuel oils and Mr. Cunliffe estimated that requirements would expand from 7,750,000 tons in 1955 to 21,750,000 tons by 1960,—an annual increase of 23 per cent each year. This, as Mr. Cunliffe pointed out, was a considerable task, calling for large capital investment, and involving the building of greater storage capacity, additional road, rail, canal and coastal transport facilities, the expansion of refinery capacity, an oil tanker building programme and more intensive exploration for oil. Some 6,000,000 tons of the extra 14,000,000 tons required by 1960 would be absorbed by the large oil-fired power stations of the Central Electricity Authority and a further 2,000,000 tons by the introduction of diesel locomotives on the railways, leaving 6,000,000 tons for other uses. Mr. Cunliffe suggested that this amount could be burned under boilers of small concerns, especially in areas where coal supplies were doubtful. The question of conversion, he insisted, was of some urgency, for it would add to the already heavy demand upon equipment manufacturers and could not be carried out without a period of delay.

Liquid Floor Coating.—A liquid floor coating, which is claimed to be resistant to wear and abrasion and to the action of such substances as oil and acids, is being made by Dohm, Ltd., 167, Victoria Street, London, S.W.1. This product is known as " Can-Tile," and is intended particularly for applications such as factory floors, but is also stated to withstand the passage of motor traffic when it is laid in the open.

An On-Off Servo Mechanism With Predicted Change-Over

By J. F. COALES, O.B.E., M.A., M.I.E.E.,* and A. R. M. NOTON, B.Sc., Grad. I.E.E.*

The problem of optimum switching in servo systems was the subject of a paper discussed at the Institution of Electrical Engineers, London, on February 14th. The authors described a method (not limited to second-order systems) of using a high-speed analogue computer for predicting the ideal switching time. They gave details of a model experiment devised by them to demonstrate the practicability of the method. The following abstracts from the introduction and conclusions to the paper indicate the scope of the work.

WHEN engineers first invented automatic controls it was natural that they should use a simple switch to make a correction whenever the quantity to be controlled was different from the desired value. It was the simplest and most obvious method and was perfectly satisfactory when only a crude control was required. These controls were descriptively referred to as " bang-bang " controls in the United States, " schwarz-weiss " (black-white) in Germany, and as " on-off " controls in this country.

As greater accuracy of control was required, the limitations of simple on-off controls became apparent, e.g. serious overshoot with step inputs and continuous hunting under conditions of no mean error between input and output. Because they are non-linear in the extreme, the general analysis of on-off controls was difficult and exact analysis laborious. However, by going to the increased complication of proportional controls, with derivative and integral terms added, not only could very much improved performances be obtained, but the systems could also be readily analysed and so designed to meet specific requirements.

All components in a control system become non-linear at some level, owing to saturation, and so, to ensure linear operation for ease in analysis, they must all be generously designed ; this results in increased size and often in increased complication. During the past few years it has become recognised that, by the appropriate use of non-linear components, control systems can almost certainly be made cheaper and smaller and, in many cases, simpler and more reliable. Unfortunately, the theory of non-linear control systems is exceedingly difficult ; thus it has been only slightly explored, and no general methods of analysis or synthesis are available. It is therefore impossible to decide what non-linear components are most likely to be useful. However, on account of their simplicity, on-off controls are immediately attractive and, as a result, a great deal has already been done on the theory.† They are also attractive for any system in which a large output power has to be controlled. In such a case the most costly part of a control system will always be the output motor, and the cost will be roughly proportional to the peak output power ; for this reason the system will usually be designed so that non-linear operation, due to saturation, will first set in as a result of curvature of the torque/input characteristic of the output motor.

If the system is designed for linear operation the maximum torque of the motor will be used only for large values of the error (input minus output) and so for small errors the load will accelerate slowly and will not catch up with the input as quickly as it might. The speed with which the output catches up the input can, of course, be increased by increasing the loop gain of the system, provided it does not become unstable. But this has the effect of reducing the linear region (proportional band), and therefore saturation and non-linear operation will set in for smaller values of the error—such values as are met in normal operation of the system. This usually results in an undesirable increase in the overshoot.

In this connection the on-off controller is effectively an amplifier of infinite gain saturating for infinitesimal values of the error, and so the output motor will always be operated at full torque, either in one direction or the other. Thus, in the case of a position control in which both input and output are at rest, if the input is suddenly moved to a new position (a step function) it is easily seen that the output will be brought into line in the shortest possible time if the full torque of the motor is used to accelerate the load for a certain time and then, in the reverse direction, to decelerate it, so as to bring it to rest exactly at the right position. The problem is, of course, to make the change-over at the correct instant of time.

*, Engineering Laboratory, University of Cambridge.

† Hazen, H. L.: " Theory of Servomechanisms," *Journal of the Franklin Institute*, September, 1934, 218, page 279 ; Weiss, H. K.: " Analysis of Relay Servomechanisms," *Journal of the Aeronautical Sciences*, July, 1946, 13, page 364.

CONCLUSIONS

For a relay-controlled servo mechanism represented by an *n*th-order differential equation one change-over, and one only, at a unique time, is necessary to bring error and error rate to zero in the least possible time. Previous workers have used the sign of a non-linear function to control change-over, but such methods are suitable only for simple second-order systems with step inputs. To satisfy the need of a technique capable of wider application (for example, systems with random inputs), a general method [as described in the paper] has been devised for achieving optimum switching with an on-off control system. The practicability of predicting the ideal switching time has been demonstrated with a model experiment for which responses to step, ramp, and parabolic input functions have been found to compare favourably with those of an orthodox system.

Using the hypothetical example of a 10kW control system, the probable saving in torque which could result if the optimum on-off servo mechanism were used has been deduced. The more powerful the control system considered the more important becomes the saving in torque, and the complications of the associated electronics can then be justified. For example, at power levels of the order of 100 h.p. a 50 per cent saving in torque (apart from the elimination of rotary power amplifiers) suggests that this method of on-off control may well have practical applications.

The design of a high-power control system would fall into two stages : (*a*) subject to practical limitations the torque reversal is made as rapid as possible ; the delay in reversing the torque may be simply that due to the inductance of the field coils, but whatever it is the second stage is (*b*) to simulate the system and the reversing torque function actually present. The best use is then being made of the available torque and mode of reversal. It is, of course, quite feasible to limit the rate of build-up of torque in any desired way, since this can be taken into account in the simulation of the actual torque function.

In conclusion it may be stressed again that, once the fast analogue computer is made, the additions required to the computer in order to simulate highly complicated motor, load and torque characteristics are insignificant. Furthermore, there is no need to know theoretical governing equations, since the computer can be made to conform to characteristics obtained from tests carried out over the working range of the system. Changes in characteristics of motor and load can easily be taken into account during life by changes to the computer.

It is envisaged that future work will include :

(*a*) An introduction of dead-zone or torque reversal in a finite time to eliminate the wasteful drain of power in hunting.

(*b*) Simulation of the character of torque reversal likely to be met in practice.

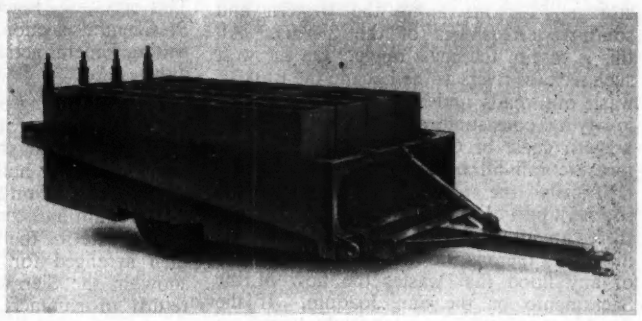
(*c*) The application of statistical methods of input prediction for dealing with random inputs in the presence of noise.

(*d*) Modifications to take into account load variations.

Heavy Rollers for Soil Compaction

WE have received from the distributors, Jack Olding and Co., Ltd., Hatfield, Herts, details of a range of heavy compaction rollers made by Onions and Sons (Levellers), Ltd. Sheepsfoot rollers and pneumatic-tyred rollers are included in the range, for different classes of soil compaction, and one of the pneumatic-tyred rollers is illustrated below.

The " Compacta " sheepsfoot roller is produced in one size, a normal arrangement comprising two individual roller drums joined by articulated joints, but in other arrangements one, three or four drums can be linked. Each drum can be filled with water for ballast and runs on a fixed axle attached to a rectangular frame ; sand or earth ballast boxes are mounted on the frame. Tapered feet are welded to the periphery of the drum, there being thirty-six rows, each with four feet, staggered to give eight lines of compaction. Each foot is 9in long and has a hard alloy steel pad 3in in diameter welded to the end. With water or sand ballasting, the ground pressure can be adjusted from 330 lb to 920 lb per square inch.



Rubber-tyred compaction roller with four ballast containers. This arrangement gives a compacting load of 760lb. per inch of tyre width, and requires a drawbar pull of 12,000lb. on a 5 per cent gradient.

The roller is for use with tractors of at least 15,000 lb drawbar pull. Construction is of welded steel, the diameter of the roller being 5ft to the bases of the feet. The drum is sealed with two screwed plugs for filling with water ballast. The feet are normally self-cleaning, it is stated, but a detachable cleaning rake can be used to remove roots and so on.

The rubber-tyred rollers are produced in two sizes, each one comprising a group of independent ballast containers enclosed within a rectangular yoke with an adjustable towbar to keep the roller in trim when towed. The yoke may be altered to take from three to six containers, each comprising a wheel, tyre and ballast box.

The containers are hinged to the front of the yoke and can move independently. At the back each one is attached to a buffer spring to damp excessive oscillation. These springs preserve the stability of the assembly and do not transfer any appreciable load from one container to another ; each container is free to move vertically with the tyre, imposing a steady load over ground irregularities.

The yokes on each of these two sizes of rollers can be adjusted by spacing bars so as to accommodate three to six independent containers, a standard roller being equipped with four. The total weight of the four-unit model " 75 " when fully ballasted with wet sand is 50,500 lb, giving a load of 760 lb per inch of tyre rolling width (the rolling width of a tyre is 1ft $4^{6}/_{16}$in). For the four-unit model " 150 " the equivalent figures are 105,500 lb and 1185 lb (tyre width 1ft $10^{3}/_{16}$in).

B.I.C.E.R.A. BULLETIN.—We have received the first number of a bulletin, which the Council of the British Internal Combustion Engine Research Association proposes to issue three or four times a year, and which will describe in general terms what goes on in B.I.C.E.R.A. The present issue gives a broad outline of the Association, a list of members of council and of committees and includes technical notes concerning recent papers and developments.

American Engineering News

BY OUR AMERICAN EDITOR

Floods in the Western United States

THE recent Christmas season was neither a merry nor a happy one for thousands in northern California and in southern Oregon. Floods resulting from four separate severe rainstorms within less than a fortnight made scores of people homeless. Many others gave up their holidays in rescue, rehabilitation and restoration work. Total damage has been estimated at more than 100 million dollars and the death toll is near 100. Several small towns were completely wiped out and Yuba City, the centre of an important agricultural region in the Sacramento Valley, was entirely inundated. These floods once more have emphasised the relative insufficiency of the existing control works, particularly in the Central Valley of California. To-day the maps show such great dams as that at Friant in the headwaters of the San Joaquin and that below Shasta in the upper Sacramento, and a whole array of water storage reservoirs along the western and south-western slopes of the Sierras. All this is east of the coast range. On the west such reckless rivers as the Eel and the Russian wash out roads and railways and threaten low-lying communities. Along the north-western coast of California the inhabitants measure rainfall by the foot. But characteristically the Central Valley and the southern part of California are areas in which there can sometimes be too much water, but in general there is too little. This is the pity of any flood that wastes the flow of the Sacramento or the San Joaquin. If the flood waters could be adequately stored we should not again see scores of lives lost and many millions of dollars' worth of property destroyed. The question that arises is how much can be spent upon a really adequate control and how much water can be recovered in the form of crops or for industrial uses. It is one of the ironies of this situation that Los Angeles—indeed, the whole great basin of southern California—has normally less naturally available water than its expanding population requires. Long ago Los Angeles thrust north to tap the Owens River in the Sierra foothills. Then it turned across the Divide to get the waters of the Colorado, held back by the Hoover dam. It now contemplates going far to the north and east of San Francisco to acquire for its purposes the waters of the Feather River—one of the very rivers that has just been in flood.

The scale and frequency of flood inundations, whether they be of relatively minor or of major proportions, escape accurate prediction except for forecasts of the potential of a hard-hitting storm or of a snow pack in the high mountains. The point was emphasised by the waters that ravaged California's Central Valley and other sections of the West last Christmas and, again, in January, and the hurricanes that swept New England last autumn. Steady rain and quick thaw that cut the snow pack in the High Sierras of the West from 8ft to 2ft in a matter of days set up the flood potential. But a sudden change in the weather could have slowed the waters and permitted a run-off, even over frozen or saturated ground, that would have minimised the danger. Once the flood waters start to roll, however, predictions of their path and likely stages become a matter of no easy computation. This was illustrated by the U.S. Army Corps of Engineers in the 1952 Missouri River flood. The Corps of Engineers ran the flood waters in the upper river through a scale model of the river at its engineering centre in Vicksburg. This test came up with the stages expected at major points, such as Omaha, Nebraska and Council Bluffs, Iowa, and enabled flood workers to plan adequate emergency protection. For years, various proposals for flood insurance have been examined in and out of Washington. Insurance companies have found no feasible means of writing insurance except at a high and prohibitive premium because they have not been able to spread the risk across the whole of the population as with such common protection as fire insurance. This situation has brought the Federal Government into the picture again and again in surveys of the whole field of natural disasters, floods, tornadoes, earthquakes, hurricanes, tidal waves, drought and others. Agitation for Federal protection runs high after each disaster, but diminishes as the disaster recedes in memory. This past year, however, the hurricanes and floods in New England, in the south, in some sections of the midwest, and now in the far west, bring together almost all sections represented in Congress. This situation, together with a forthcoming Presidential election, is most favourable for getting Federal action on broadened Federal disaster aid.

The engineering problems, like the human problems, of water in California are complex. Nature provided the state with a rainfall distributed over half the year or less, heavy in the north and on the coast and diminishing in the south and the interior. As though to compensate for the long, dry season, Nature then arranged for heavy seasonal falls of snow in the Sierras. These melt with the return of summer, so that the rivers are reinforced at the very time when there is little or no rainfall to fill them. The snow is stored energy. But if there is too much rain in the lowlands and the weather turns unseasonably warm in the mountains, then there are floods, then the waters become a destroying agency. Proposals for the control of the waters of California were made as long as a century ago, and have been increasing in their reach ever since. The Bureau of Reclamation has been thinking not in terms of millions of dollars but of hundreds of millions, approaching a total of 2000 million dollars. Indeed, this latter sum is not too great for a vast community, whose population may be close to 15,000,000 within a year; it is this great enterprise that has been made more urgent for California because of the recent floods. The great modern community can die of thirst and it can be paralysed by too much water. California has suffered the extremes and cannot afford to postpone remedial action any longer.

School for Advanced Study at M.I.T.

THE establishment of a School for Advanced Study at the Massachusetts Institute of Technology was announced last month by Dr. James R. Killian, Jr., President of the Institute. The new school will provide means by which post-doctoral scholars from all over the world can join with the M.I.T. faculty in high-level theoretical studies and research. Dr. Martin J. Buerger, professor of mineralogy and crystallography, has been appointed director of the school. According to Dr. Killian, the advance in knowledge makes it increasingly important for scholars to pursue advanced study beyond the level of the graduate school and the doctor's degree, and the advancement of American science particularly requires more post-doctoral study and research in American educational institutions. In its initial embodiment the school will be simply an organisational entity, but it is hoped ultimately to provide a centre and adequate housing for fellows and guests and by this means to gain the advantage of cross-stimulation of ideas which occurs when learned and ingenious men are brought together into close social contact. Scholars who are invited to M.I.T. for advanced study will have the status of "fellows" in the school. This year there have been approximately 100 such people from fifteen countries, studying at the Institute, and they have been registered as "guests" or "visiting fellows." Ordinarily, such visiting scholars do not enrol in courses or seek degrees, and M.I.T. has not asked them to pay tuition fees. The majority are supported by fellowships or grants.

The school will be similar in its objectives to the Institute for Advanced Studies at Princeton University, where Albert Einstein spent the latter years of his life. Unlike the Princeton School, the M.I.T. School for Advanced Study will be an integral part of the Institute and constitute an extension of the level of the programmes of the undergraduate and graduate schools. These three schools will constitute the "horizontal" schools of M.I.T. Professors participating in its activities will remain on the faculties of the five "vertical" schools—those of Science, Engineering, Architecture and Planning, Industrial Management, and Humanities and Social Studies. Its special staff, to begin with, will consist only of the director and a secretary. Dr. Buerger, who will assume the office of director on July 1st, has been at the Institute since 1920, when he came as a student. He has been on the staff since 1925, when he was appointed a teaching fellow. He became a full professor in the Department of Geology in 1944 and is now chairman of the Institute faculty.

Industrial Plants for the Chemical Processing of Irradiated Nuclear Fuel Elements

THE U.S. Atomic Energy Commission has approved a programme to encourage private industry in the United States to build and operate plants for the chemical processing of irradiated fuel elements from research and power reactors, as a further step toward private ownership of atomic energy facilities for peaceful uses. These chemical processing plants constitute an integral portion of the fuel cycle of nuclear reactors. They perform the operations of recovering the fissionable and fertile materials present in the irradiated fuel elements for re-use, and of placing the radioactive fission products in disposable or usable forms. So far, these operations are being performed only by Government-owned plants at various Atomic Energy Commission sites.

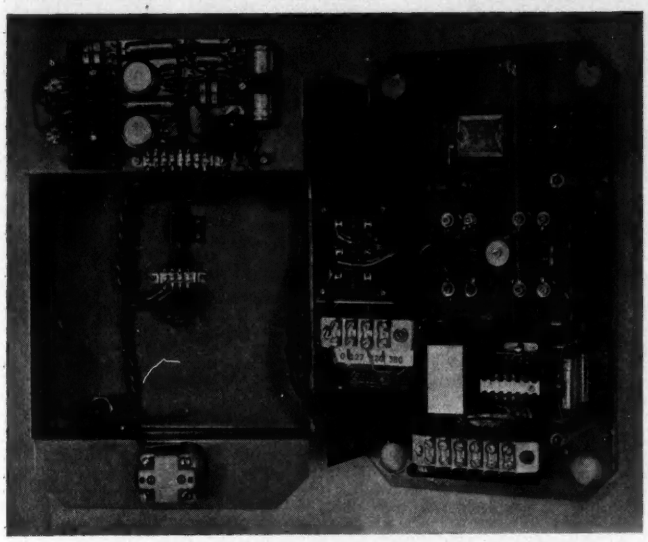
It is now the policy of the Commission to encourage industry to build its own plants for these purposes. The goal is to have commercial processing plants in operation as it becomes necessary to process fuel elements from privately-owned power reactors. The Atomic Energy Commission will make available : (1) Commission technology in the field of chemical processing to interested firms, and (2) limited amounts of certain irradiated fuel materials from A.E.C. reactors for processing by industry, to the firms which submit acceptable proposals to the Commission at a date to be specified, about eighteen months from now. Commission facilities may also be utilised by private firms for research and development, and training in connection with the chemical processing field. The full costs of such utilisation would be defrayed by the user. In evaluating these proposals, the Commission will take into consideration such factors as the advancement of chemical processing technology which will result from the construction and operation of the proposed plant, reasonableness of prices, size and start-up date of the commercial plant, and assurances against abandonment of the project. Another criterion on which proposals will be evaluated is the manner in which the waste disposal problem will be handled. This criterion has been established in order to give industry the greatest possible incentive to reduce the cost and risks connected with this operation and to develop economical uses for the radioactive materials which are now generally regarded as waste products. On the basis of its evaluation, the Commission may select one or more of the proposals which it receives, or it may reject all.

Continental Engineering News

Industrial Metal Detector

Electronic metal detectors operating by means of search coils fall into two main groups. "Balanced coil" detectors, deriving from the wartime mine detector, make use of a radio-frequency sender coil which sets up opposing voltages in a pair of reverse-connected receiver coils. Any unbalance in the receivers due to the introduction of test material causes an external signal voltage which, after amplification, can be used to operate a relay. In order to maintain a high sensitivity the receiver coils must be balanced for both amplitude and phase—two interdependent quantities—to a very high degree. This requirement leads to mechanical difficulties with the construction of the coils and to electrical complexities.

The second group, the "single-coil" detectors, depend for their operation on the material under test to be passed through or over a single search coil, at a speed in excess of a certain minimum. The search coil is made the tank coil of a radio-frequency oscillator. Any conducting specimen introduced has a twofold effect. By increasing the losses it causes a very slight increase in the oscillator anode current. The frequency of the coil is also affected, both by a decrease in inductance due to eddy current losses in the specimen, and an increase in inductance due to permeability, if the specimen is magnetic. Since for certain combinations of specimen size and permeability these effects cancel each other, the change in frequency is not a good indicator for magnetic metals or ores.



Control unit of metal detector (interior view).

Research undertaken by Asea, of Västerås, Sweden, has led to the development of the "Asdet," an industrial detector of the single-coil variety, which is stated to have a very high sensitivity and at the same time to be of simple and robust design. With this model, shown in the accompanying illustration, the same amplifier and power supply can be used with a series of different coils covering most requirements likely to arise. Only four valves are employed and no adjustment or balancing of oscillator coils is necessary. Among the important applications of this instrument are the detection of tramp metal in magnetic iron ore, the recovery of expensive metals from slag, and possibly the automatic cleaning of coal.

In the "Asdet" detector, use is made of the transient effect on coil losses when a specimen passes rapidly through (or over) the search coil. Simultaneously produced changes in frequency (up to about 3 per cent) are disregarded by the instrument. For particles to be detected with maximum sensitivity they must pass the search coil at speeds of about 10cm per second or more, the maximum velocity being unlimited. Objects at rest near the coil are not indicated and have but little effect upon the sensitivity. The latter is such that reductions in output voltage of 10 per cent have been observed for particles the introduction of which reduced the Q-factor of the search coil by an amount which was not detectable, i.e. less than 0·1 per cent.

The electric circuit consists of the search coil, the oscillator (amplifier with feedback loop), an amplifier, a rectifier (supplying an automatic control voltage to the oscillator, with time delay), a second amplifying stage, and a time delay flip-flop operating a relay.

The sensitivity of the instrument is increased very substantially by reducing the amplitude of the free oscillations, by applying a negative bias to the oscillator control grid. In this way the oscillator can be operated at a point where a particle introduced into the coil causes the output voltage to fall to zero. For the oscillator to operate in a stable manner the attenuation in the feedback must equal the gain in the amplifier (loop gain=unity); a goal which is achieved by employing a rectifier to rectify the oscillator output and applying the resulting d.c. to the amplifier control grids in such a way that an increase in output voltage reduces the gains of the amplifier. Since to do this in the normal way would nullify the effect produced by a test particle, a time delay must be introduced. A second amplifier stage with a gain of about 10 operates a time delay flip-flop which actuates a relay. The relay is used to control a sorting gate or equivalent mechanism, and the time delay is made adjustable from 0 to 3 seconds or up to several minutes, if necessary, to allow the test particle to reach the gate. This, and the adjustment of sensitivity, are the only controls which have to be operated after installation.

Coils can vary from a minimum diameter of 6mm up to sizes limited only by considerations of strength. Since slight distortions do not appreciably alter the Q-factor of a coil, these have no effect. Coils are encased in plastics to protect them from dirt and moisture. They are connected to the instrument by means of a coaxial cable. The size and shape of the coils depend upon the material to be inspected; where very small particles are to be indicated, the coil aperture must also be small, since the minimum detectable particle size is about 1 per cent of the aperture. The agent for the United Kingdom is Asea Electric, Ltd., Fulbourne Road, Walthamstow, London, E.17.

Fifth European Machine Tool Exhibition

The decision has been reached by the European Committee for the Co-operation of Machine Tool Industries, to hold the next European exhibition from September 15 to 24, 1957, in Hannover. The German organisation, the Verein Deutscher Werkzeugmaschinenfabriken, Frankfurt/Main, Am Hauptbahnhof 6, has been given the task of organising the event and will later on this year announce further details.

It will be recalled that the first cycle of European machine tool exhibitions started in 1951 in Paris, to be followed by Hannover, Brussels and Milan. It was later decided to continue the exhibitions on a biennial basis, and to hold the first one of the new cycle again in Paris. This was to have taken place on a new site which, it now appears, would not have been ready in time, hence the decision in favour of Hannover.

The member countries of the European committee are at the present time Belgium, Germany, England, France, Holland, Italy, Sweden and Switzerland. For the European exhibitions it was agreed to admit only firms who undertake not to exhibit at any other exhibitions in any member country in the same year.

African Engineering News

BY OUR SOUTH AFRICAN CORRESPONDENT

Union Railway Development: Five-Year Plan Under Way

The first work to be undertaken under the new five-year plan of railway improvement and expansion includes the building of additional railway track to serve coal-producing mines in the Witbank area and adjoining districts of the Transvaal at a cost of more than £1,200,000. Work is being started immediately on doubling the line between Saaiwater and Bezuidenhoutsrus, on laying down a third road between Arbor and Argent and between Delmas and Eloff, and on increasing the capacity of the Welgedag marshalling yard.

If the proposed expenditure of £1,214,000 is added to the cost of the Springs-Natalspruit line (£1,836,950) which was built to speed up the movement of coal to destinations west and south of Johannesburg, it will be seen that the total capital cost of the Railway Administration's programme to accelerate the rail transport of coal from the Transvaal collieries is £3,050,950.

Improvements in the Eastern Transvaal area, started as long ago as 1946 with the building of a single line from Oogies to Vandyksdrif, which was extended to Broodsnyersplaas in 1950, when two new collieries were opened. In 1952 it became necessary to double the section between Oogies and Saaiwater, a distance of 7 miles, at a cost of £326,000. This, incidentally, was the first branch line ever to be doubled by the South African Railways.

It was originally estimated that the Oogies-Saaiwater line would handle about 1,200,000 tons of coal per annum, but the traffic has increased beyond all expectations and the total tonnage now amounts to nearly 40,000 tons per day, i.e. 14,000,000 tons per year. With some of the mines in the area nearing the end of their lives, the country will have to rely to a greater extent on the mines served by the Oogies-Broodsnyersplaas branch and it is expected that by 1960, the line will have to handle 63,000 tons of coal per day.

The major aspect of the new work is to extend the doubling of the line from Saaiwater to Bezuidenhoutsrus, a distance of 9 miles, and then to Vandyksdrif, a further 6 miles, at an estimated cost of £570,000. The second phase of this scheme is the trebling of the line between Arbor and Argent (5 miles) and between Delmas and Eloff (5 miles) on the Germiston-Witbank line. The cost is estimated at £412,749, and includes £2749 for the installation of auxiliary block working.

S.A. Engineering Achievement in Helical Gear Manufacture

The largest helical gear ever to be forged and machined in South Africa is now being completed in the Benoni workshops of David Brown, Ltd. The gear, which weighs 13 tons, is for the S.S. "Tanganyika," a German ship built at Hamburg and now lying in Durban harbour after damage to the main propulsion gear. It was first decided that the damaged gear would have to be flown to Germany for repair, which would have kept the ship idle for four and a half months and would have cost the owners £60,000 in demurrage alone. At this stage a representative of David Brown, Ltd., flew to Durban, where, after a prolonged inspection, it was decided that his firm could undertake the job provided that the forging could be done. No forging of this size had been made before in the Union but ISCOR officials were sure that it could be done in five days after the original gear had been delivered to them. The forging, which weighs 6 tons, was cast in Pretoria from a 15-ton ingot, and this is being machined by David Brown's, according to specifications laid down by German Lloyd.

It will take three weeks to finish the job and the "Tanganyika" will be held up in Durban for only six weeks.

Raising of Kafue Bridge

Reference has previously been made to the railway decision to raise the Kafue railway bridge, which consists of thirteen spans of 100ft each, to give a greater margin of safety over exceptionally high flood waters such as those

attained in 1952 when the water was only 11in below the steelwork.

This major work was started about the middle of 1954—the first operation being to strengthen all the foundations preparatory to actually lifting the bridge by 7ft. Early in January last, the river having risen only moderately up to that date, saw all foundation work finished just before the rising flood waters overtopped the steel-piled cofferdams.

The next stage was to prepare for actual lifting of the spans and the raising of the approach embankments on the basis that the bridge would be raised in seven successive lifts of 1ft at a time at intervals of some days. Some months ago actual lifting commenced and on Friday, August 19th, the last lift was successfully carried out in under four hours. The total weight of steelwork to be lifted amounted to some 1050 tons. The successful completion of the work reflects much credit on the railway staff, who planned and carried out the operations in spells of only a few hours' duration, while keeping heavy rail traffic moving without any interruptions.

New Gold Extraction Pilot Plant in Southern Rhodesia

A pilot plant, designed to apply a new gold extraction process which promises to increase and cheapen the production of gold, has been built in Southern Rhodesia by a British firm and is said to be operating successfully. The process has been developed at the United Kingdom Chemical Research Laboratory at Teddington.

It is stated that the process may bring back into use goldfields that have been abandoned as uneconomic. This new process follows the old up to the crushing of the rock ore and its solution in cyanide. Thereafter, however, several stages of the old process, among them the mixing of zinc dust, are by-passed in the new method by the use of a bed of synthetic resin. When the solution is passed through this bed the synthetic resin readily absorbs the gold. Handling and the consequent losses are very much reduced.

The resin also absorbs other metals, notably nickel, which can be easily extracted. In the older processes the nickel goes to waste, since the method of removing it prevents it from being economically recovered. Nickel recovered by the pilot plant has been enough to contribute substantially to the operating costs.

Progress in Conversion of Brine to Fresh Water

South Africa is co-operating with three other countries in an attempt to speed up the development of large-scale plants for converting brine to fresh water. Previous processes attempted, such as the expensive distillation process used in South-West Africa, were uneconomic, but a new process known as electro-dialysis now under investigation, has better possibilities. In this process, plastic membranes, under the influence of an electric current, separate mineral salts from saline water. South Africa has made considerable progress with the practical application of this process, research in this field being undertaken by the National Chemical Laboratory, in collaboration with interested mining groups in the Orange Free State.

New Lever Brothers Factory Opened at Boksburg

This factory which was opened on October 13th, has been built at a cost of £1,500,000, on a site in Boksburg, near the main oil-seed producing areas of the Union. Over the past ten years the annual oil seeds crop has increased from a value of £200,000 to £7,500,000, which represents a significant extension to the country's agricultural activities, and makes an appreciable contribution to the national income.

£20,000,000 Railway Programme in Natal

A railway development programme to cost £20,000,000 has been started in Natal. This is to include a new marshalling yard at the Durban bayhead, which will have thirty-two lines for receiving traffic and forty-two for shunting. Other works that have been authorised are the quadrupling of the line between Durban and Booth and doubling of the line between Maritzburg and Ladysmith.

Launches and Trial Trips

CLAN ROSS, cargo and passenger liner; built by The Greenock Dockyard Company, Ltd., for the Clan Line Steamers, Ltd.; length between perpendiculars 465ft, breadth moulded 65ft 6in, depth moulded to upper deck 39ft 7½in, deadweight 10,000 tons on 27ft 3in mean draught, gross tonnage 7775 tons; twelve passengers; three complete decks, five cargo holds, ten 5-ton, four 7-ton and two 15-ton derricks, also one 80-ton and two 40-ton heavy-lift derricks; electric deck machinery, three 260kW diesel-driven generators; one set of Parsons double reduction geared triple-expansion reaction turbines, 9400 service s.h.p. at 106 propeller r.p.m., maximum power 10,340 s.h.p., steam supplied at 415 lb per square inch and 750 deg. Fah. by two Babcock and Wilcox boilers. Launch, January 17th.

DOLIUS, passenger and cargo liner; built at Belfast by Harland and Wolff, Ltd., for Alfred Holt and Co.; length overall 485ft, length between perpendiculars 452ft 9in, breadth moulded 62ft, depth moulded 35ft 3in, gross tonnage 7960; twelve passengers; two complete steel decks, four main cargo holds, derrick complement includes one to lift 70 tons; two 450kW diesel-driven generators, one 280kW gas turbine-driven generator; one oil-fired vertical boiler, one silencer boiler and two auxiliary silencer boilers; one single-acting, two-cycle Harland and Wolff opposed-piston oil engine, six cylinders 750mm diameter by 2000mm combined stroke, 112 r.p.m. Trial, January 5th.

DUKE OF ARGYLL, passenger and cargo ship; built at Belfast by Harland and Wolff, Ltd., for the British Transport Commission; length overall 375ft, length between perpendiculars 354ft, breadth moulded 55ft, depth moulded to main deck 19ft 6in, gross tonnage 5075; 600 first-class and 1200 third-class passengers; two complete steel decks, ten watertight bulkheads; three 240kW diesel-driven generators, one 50kW emergency generator, two sets of double-reduction geared turbines; 10,500 total s.h.p. at 225 propeller r.p.m., two Babcock and Wilcox integral furnace boilers supply steam at 350 lb per square inch and 700 deg. Fah. Launch, January 12th.

RED ROSE, trawler; built by John Lewis and Sons, Ltd., for the Iago Steam Trawler Company, Ltd.; length between perpendiculars 135ft, breadth 26ft 6in, depth 13ft 3in, gross tonnage 402; electric-hydraulic steering gear, electric trawl winch to take 1000 fathoms of 2¾in warp, fish room 9300 cubic feet; British Polar five-cylinder diesel engine of 800 b.h.p. at 250 r.p.m. Trial, January 18th.

Miscellanea

LONG WELDED RAILWAY RAILS.—An experimental mile length of welded track is to be laid on the up fast line at Cheddington, between Leighton Buzzard and Tring, by the London Midland Region of British Railways. The rails are to be delivered to site in 300ft lengths and, when laid, will be welded into a continuous length of 1 mile. The track has been specially reballasted to receive the rails, which will rest on grooved rubber pads on concrete sleepers and be fastened by a new kind of clip, as described in our issue of January 27th last.

HIGH-PRESSURE HYDRAULIC GEAR PUMPS.—A range of pumps operating at up to 1500 lb per square inch has been introduced by the gear division of George Angus and Co., Ltd., Newcastle upon Tyne, under the name of "Norga." Seven sizes offer deliveries from 2 to 16 gallons per minute: they are provided with horizontal or vertical pedestals or for flange mounting. The latter variant can be supplied complete with a power take-off adaptation and control lever suitable for commercial vehicle gearboxes, or directly mounted on an electric motor. The shafts of the pumps run in ball bearings, and renewable phosphor bronze wear plates flank the gears.

REBUILDING PLAN FOR PLYMOUTH STATION.—It has been announced that plans have been approved in principle by the British Transport Commission for the complete reconstruction of Plymouth North Road Station at an estimated cost of £1,500,000. Under these plans the existing station buildings will be replaced by an eight-storey building incorporating the usual station facilities on the ground floor and staff offices above. Improvements to the existing operating facilities will include a replanned track layout and an additional down platform. Multiple-aspect signalling and one signal-box will replace the six separate boxes at present in use.

COLONIAL CIVIL ENGINEERING.—The Institution of Civil Engineers is holding in June its customary biennial conference on civil engineering problems in the Colonies. The conference will be held, as usual, at the Institution building in London, and includes numerous visits to places of engineering interest in and around London. Lectures will be given on aerial surveying and on colonial development and welfare in the West Indies, and at the three principal technical sessions there will be, respectively, papers on water supply in Lusaka and Mombasa, and the planning of a new township in Aden; railway developments in West and in East Africa; and irrigation in Malaya, and the construction of a road bridge and a power station in West Africa.

PROCESS TIMER.—A new seconds timer with an 8in diameter dial has recently been added to the range of industrial process timers made by English Clock Systems, Ltd., 179–185, Great Portland Street, London, W.1. The main dial of the timer indicates seconds from 0 to 60 and a bold subsidiary dial shows 0 min to 10 min. A substantial metal case is designed for using the timer as either a free-standing instrument or as a permanent fitting, using the holes drilled in the rear flange of the timer for fixing purposes. The timer is started by depression of a lever projecting from the side of the case, and it stops when this lever is returned. To reset the hands to zero a plunger at the top of the timer is depressed, by which action also the instrument is rewound in readiness for the next operation.

TESTS ON TWO PRESTRESSED WATER TANKS.—A report published by the Cement and Concrete Association, 52, Grosvenor Gardens, London, S.W.1, describes a series of tests carried out during the construction of two prestressed water tanks, 75ft in diameter and 19ft in height, to discover the losses in stress caused by friction and the stress distribution in the walls at various stages of construction. It was found that friction loss as in the vertical cables were appreciably in excess of the design assumptions, and that this excess was due to the method adopted for securing the cables and to the type of sheath used. The mean losses for the vertical cables were about 30 per cent. The horizontal stressing procedure involved friction losses which were practically identical with those in the design assumptions. The actual and theoretical stress distributions, apart from those dependent on the vertical stressing, showed quite good agreement.

MERSEY TUNNEL GAS MAIN.—To effect a completely integrated gas scheme on both sides of the Mersey, the North Western Gas Board recently installed a new 18in diameter high-pressure gas main through the lower half of the Mersey Tunnel. The Gas Board appointed Welding Supervision, Ltd., to effect the entire welding and radiographic control on the pipeline. Owing to the important nature of the gas main, it was essential that the welding should be of a very high standard and special radiographic inspection techniques and equipment were devised by Welding Supervision, Ltd., for the joints. A special sectionalised and prefabricated test and radiographic laboratory was erected in the lower half of the tunnel where the gas main was laid. This laboratory was made in sections that would pass through small bulkhead apertures in the pipeline tunnel, and it was frequently moved during the construction of the pipeline, so that the time between taking an exposure and the classification of the weld was reduced to a minimum.

MARINE ENGINEERS' MEMORIAL BUILDING.—It was on November 16th that H.R.H. The Duke of Edinburgh laid the foundation stone of the Institute of Marine Engineers' National Memorial Building which commemorates the 3458 marine engineers lost during the war. We recently paid a visit to the site and noted that, during the intervening months, rapid progress has been made in the construction of the reinforced concrete foundations and basement up to street level, including the underground garage, bomb shelter and lift shafts. It is considered by the Institute that the advancement of the work is sufficiently encouraging to believe that the original completion date of September, 1957, will be kept or even anticipated. However, it is regretted that there has been a steady increase in costs, the effect of which will not be felt fully until the building is completed, and to meet this enforced additional expenditure the Institute is making a new appeal to its members for further subscriptions to aid in the financing of the scheme.

TRAINING IN ELECTRICAL ENGINEERING.—A brochure has been issued by the Belmos Company, Ltd., Bellshill, Lanarkshire, dealing with the firm's training facilities for engineers for the electrical industry. The training scheme is arranged in three main categories. Under the scheme for electrical engineers at the Bellshill factory the apprentice in his first four years is given training in unit erection, workshop practice, coil winding, final erection, equipment testing and experimental bench work. In his final year he specialises in a branch of work for which he shows particular aptitude. There is also an apprenticeship course for machinists and toolmakers. An electrical engineering course at the firm's Blantyre factory covers training in workshop practice, panel wiring, sheet metal work, and erection. For student apprentices a short training scheme of six months is provided for students of universities and colleges, and for those whose vacational work cannot extend beyond ten weeks. A graduate training scheme in practical electrical engineering, lasting two years, is also provided for men who have already obtained an electrical degree or diploma.